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GB 1566444 GB 1350799  
GB 1543258 GB 1337862  
GB 1414657 GB 1196174  
GB 1399273 GB 1189204  
GB 1383944 GB A 2106257

(58) Field of search  
B3B  
B4B  
B5A  
G1X

## (54) Improvements In or Relating to Computer Controlled Tools for the Production of Graphic Material for Use in Colour Printing or Like Processes

(57) A head (15) carrying a registration hole forming tool (4), marking out tool or mask forming tool is driven with at least two degrees of movement over a work supporting surface (2) with the registration hole forming tool (4) being driven out of contact with the work (3) and then being driven into contact with the work (3) when at least one predetermined location is reached and said marking out and mask forming tools being driven in contact with the work, with the head movements being controlled by a computer (35) through a drive function (37) connected to means for driving the head (15) over the work supporting surface (2), the computer (35) being fed with a computer programme (CRD) for registration hole forming or a computer programme for marking out and mask forming, so that registration holes (4a), marking up lines or mask forming lines are formed in the work to produce graphic material which may be used in the graphic arts such as colour or like printing processes and sign making.

The head (15) is driven along a guide 14 supported on carriages (11, 12) which may be driven in unison along respective racks (9, 10).

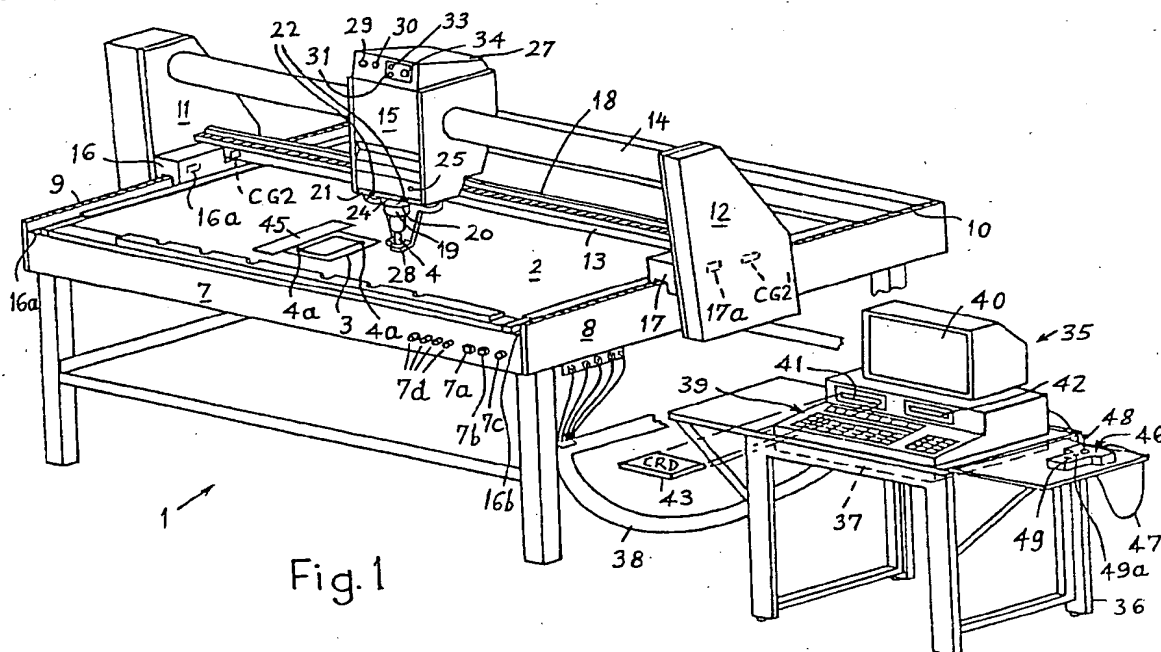


Fig. 1

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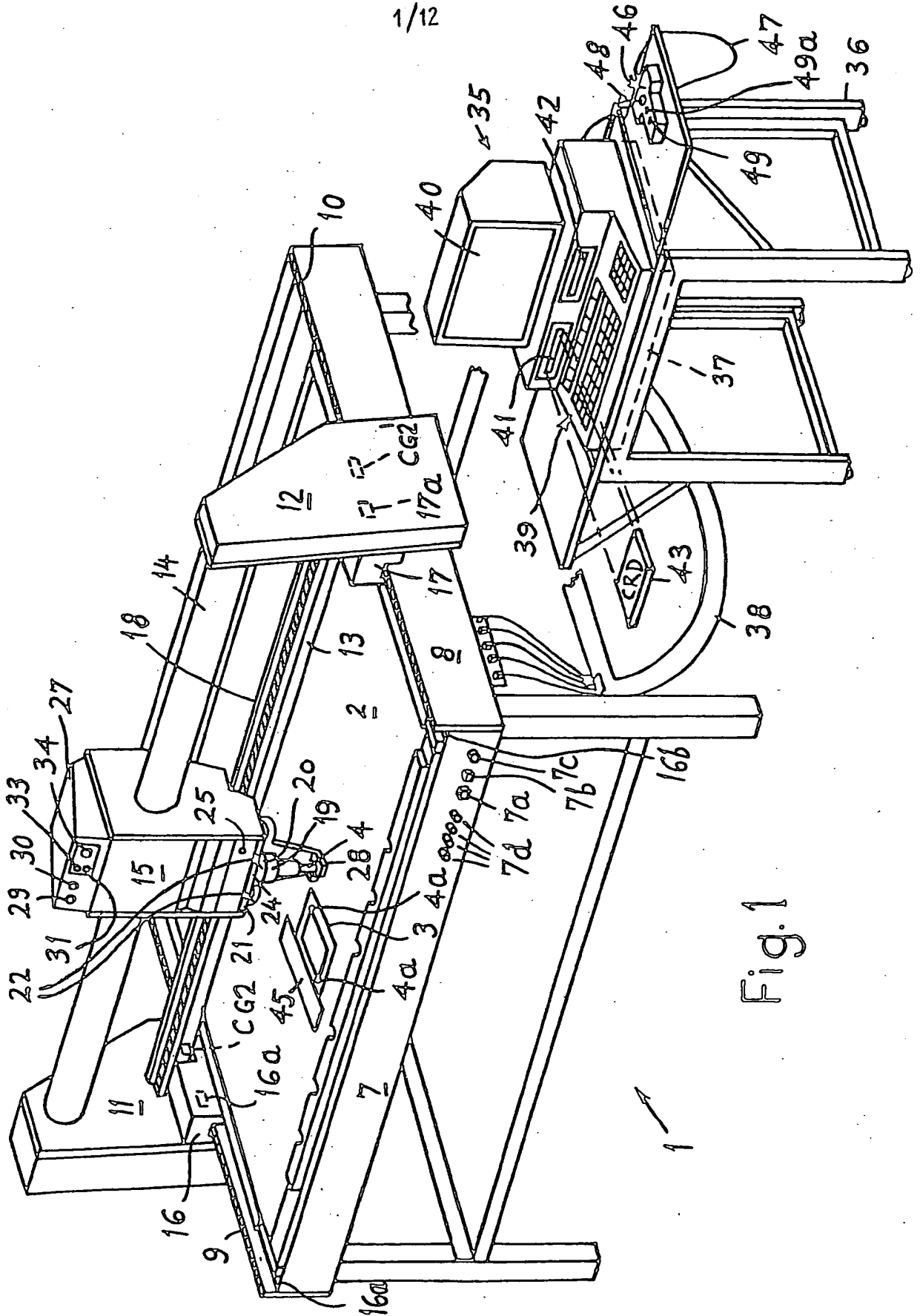
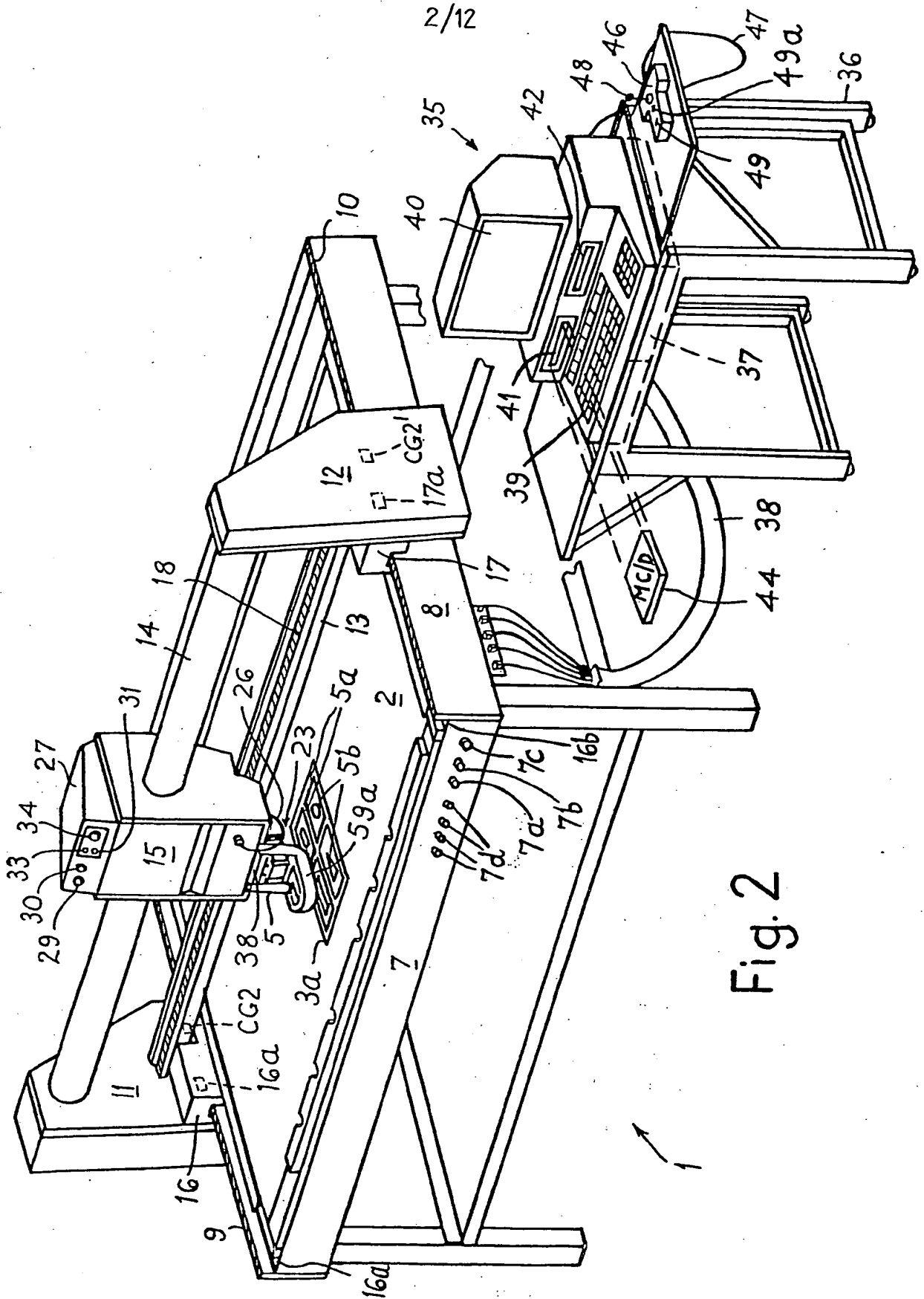


Fig.1



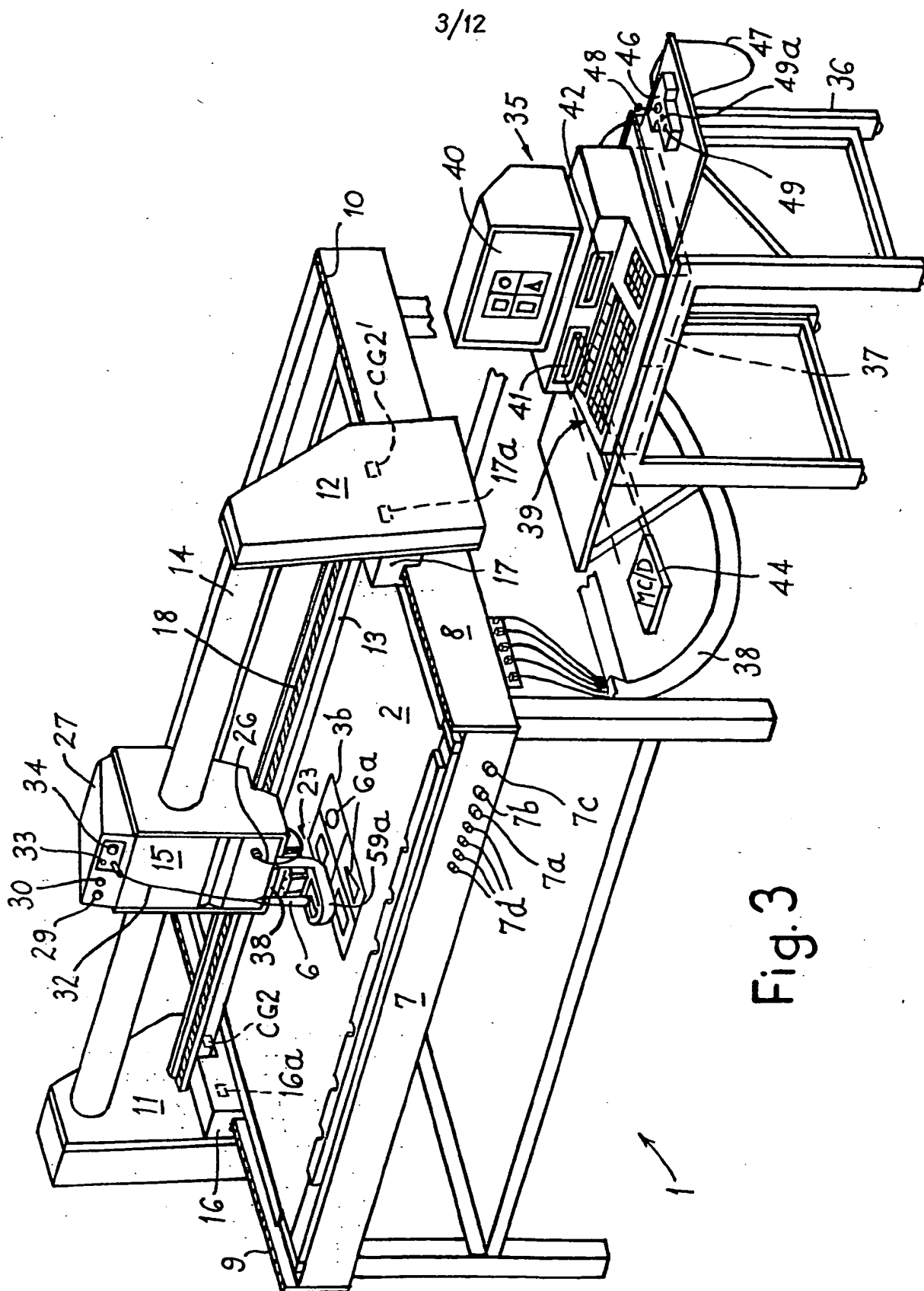
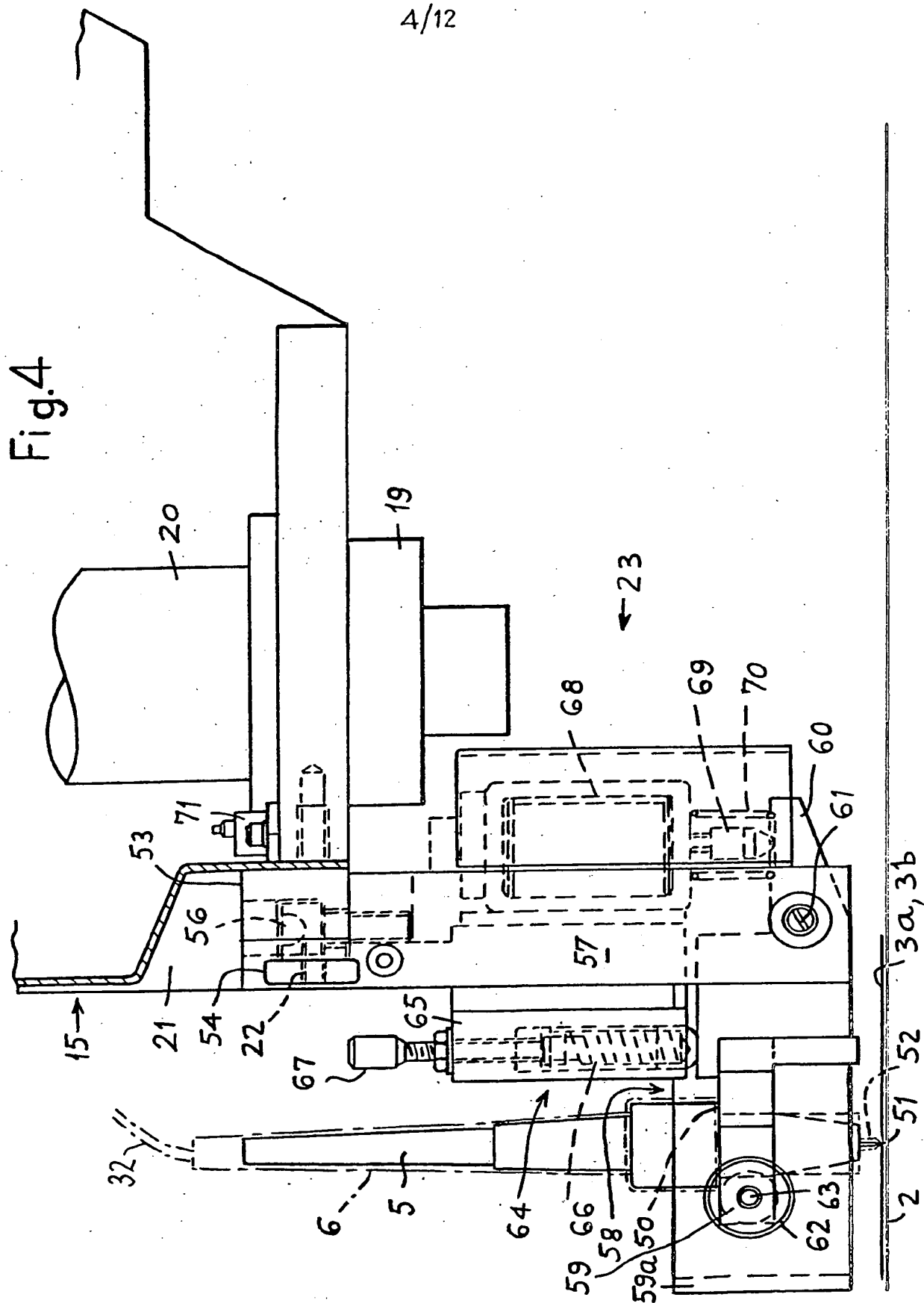
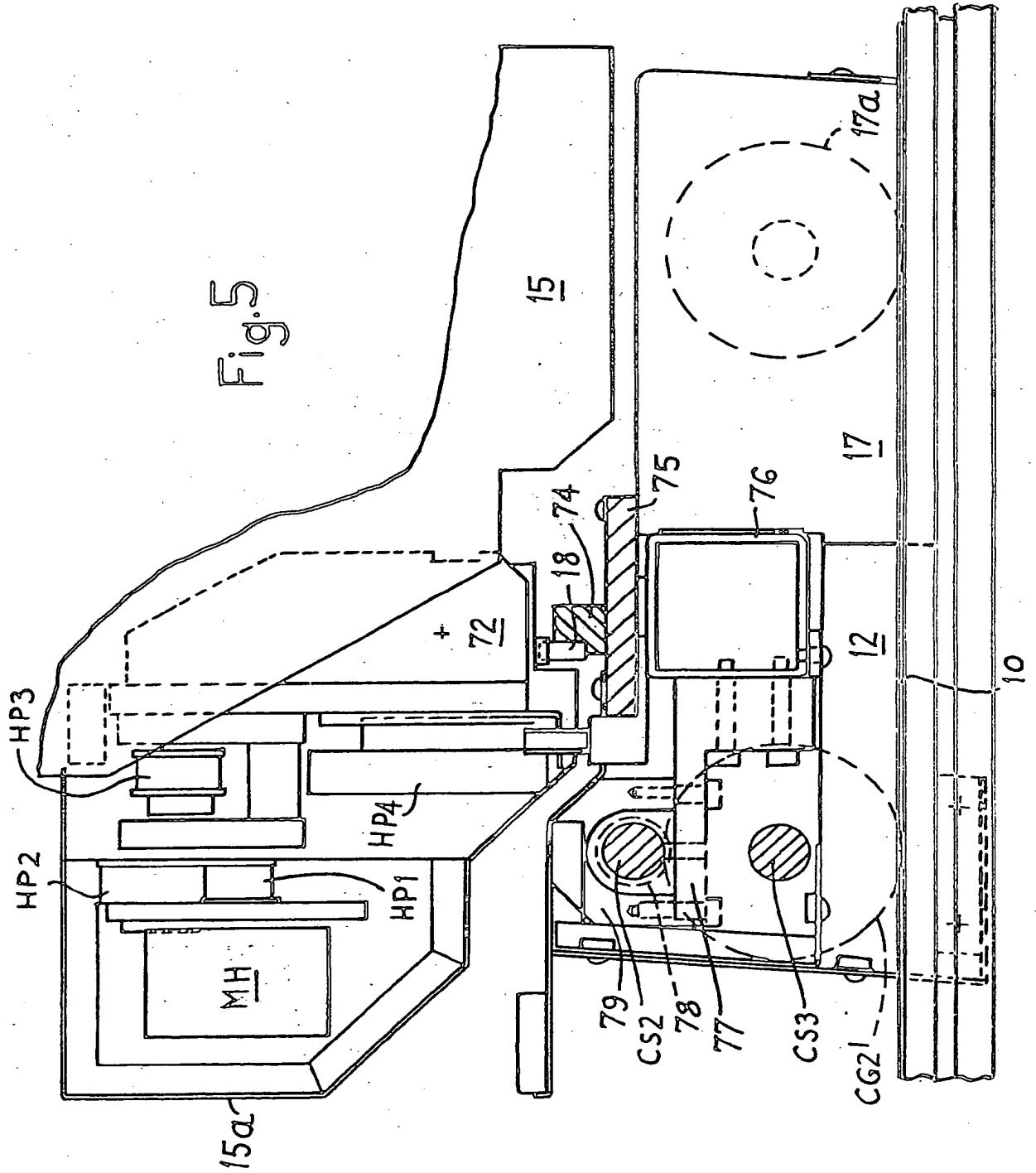


Fig.4





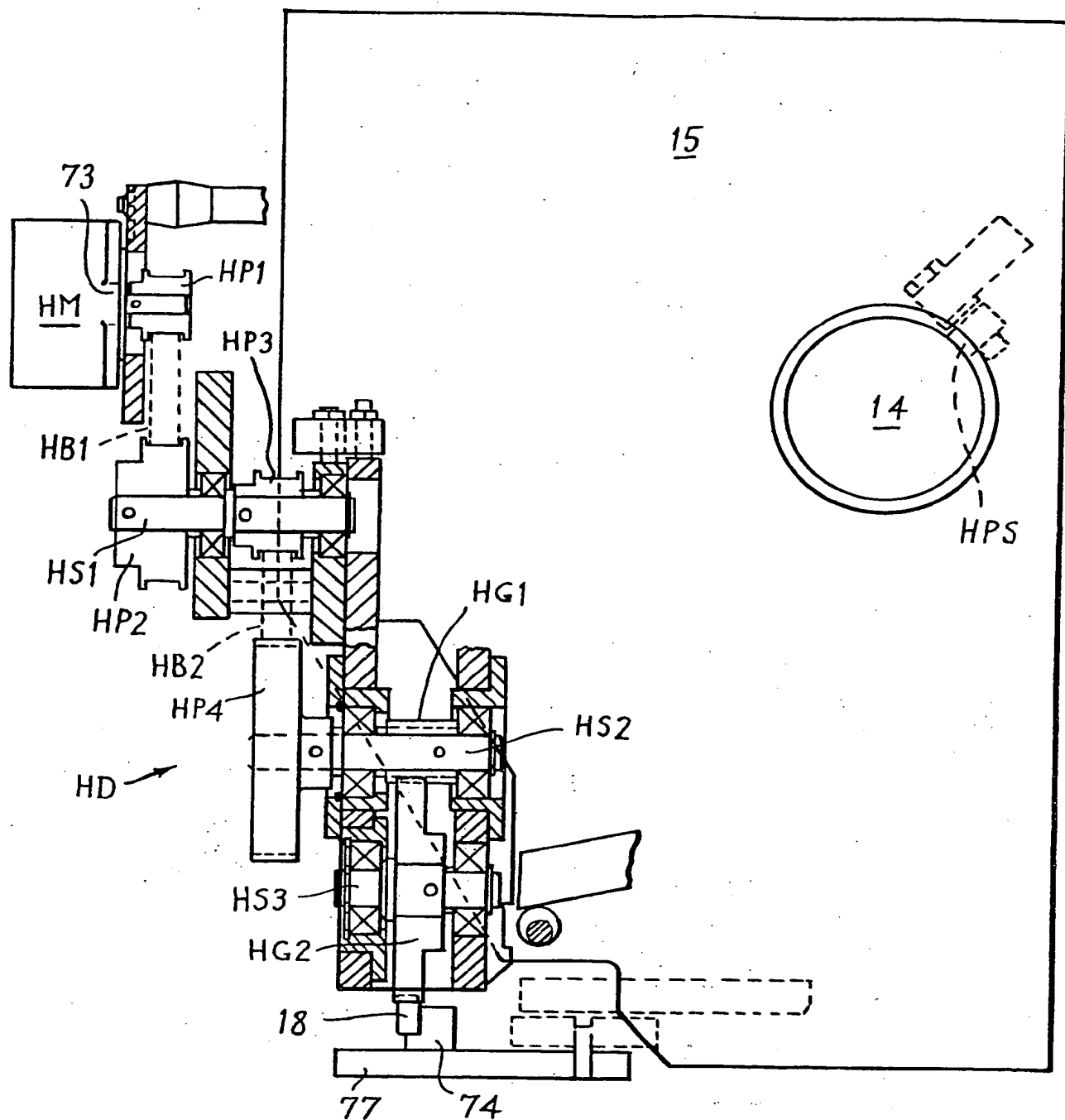


Fig. 6

7/12

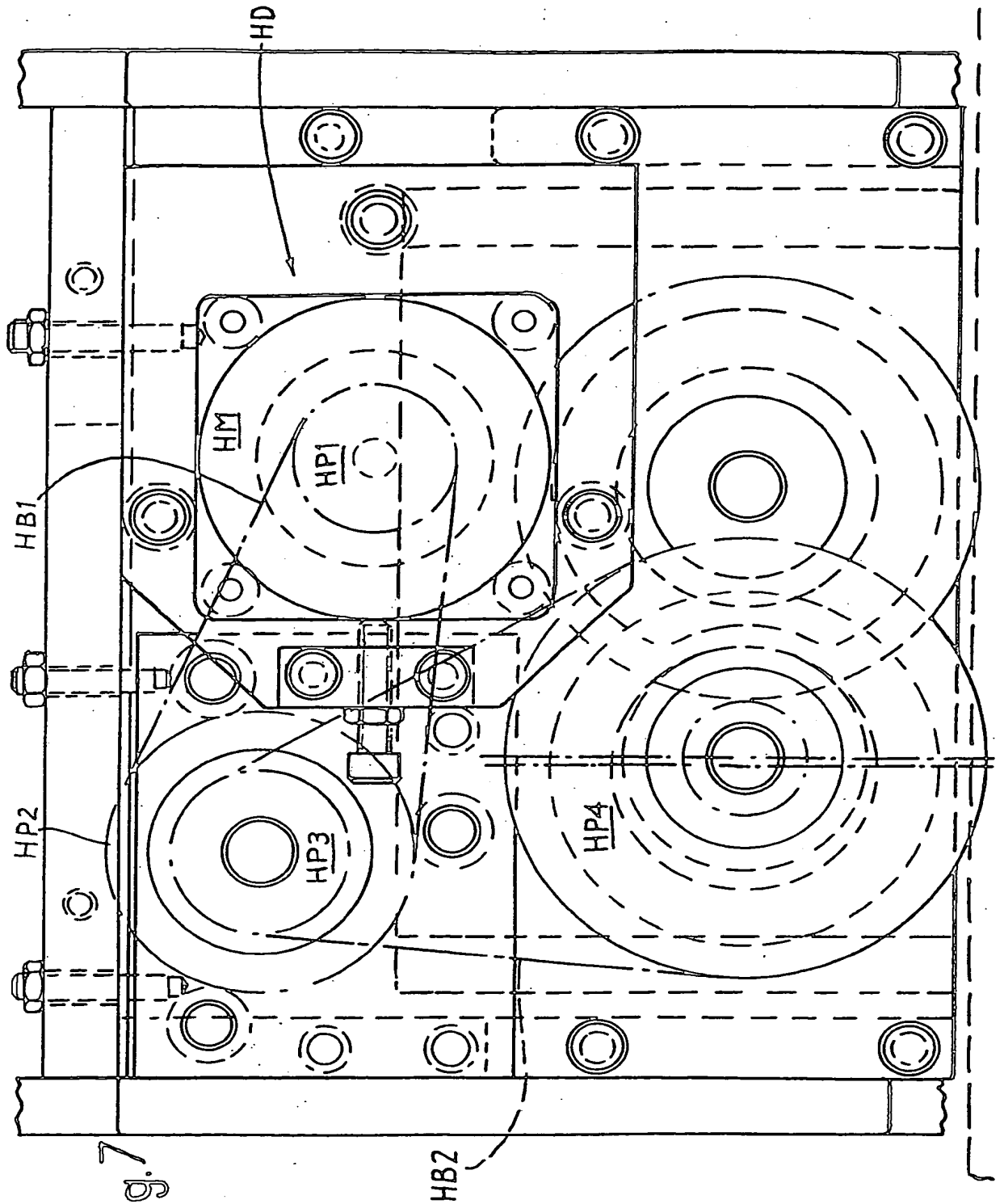


Fig. 7



9/12

Fig.9

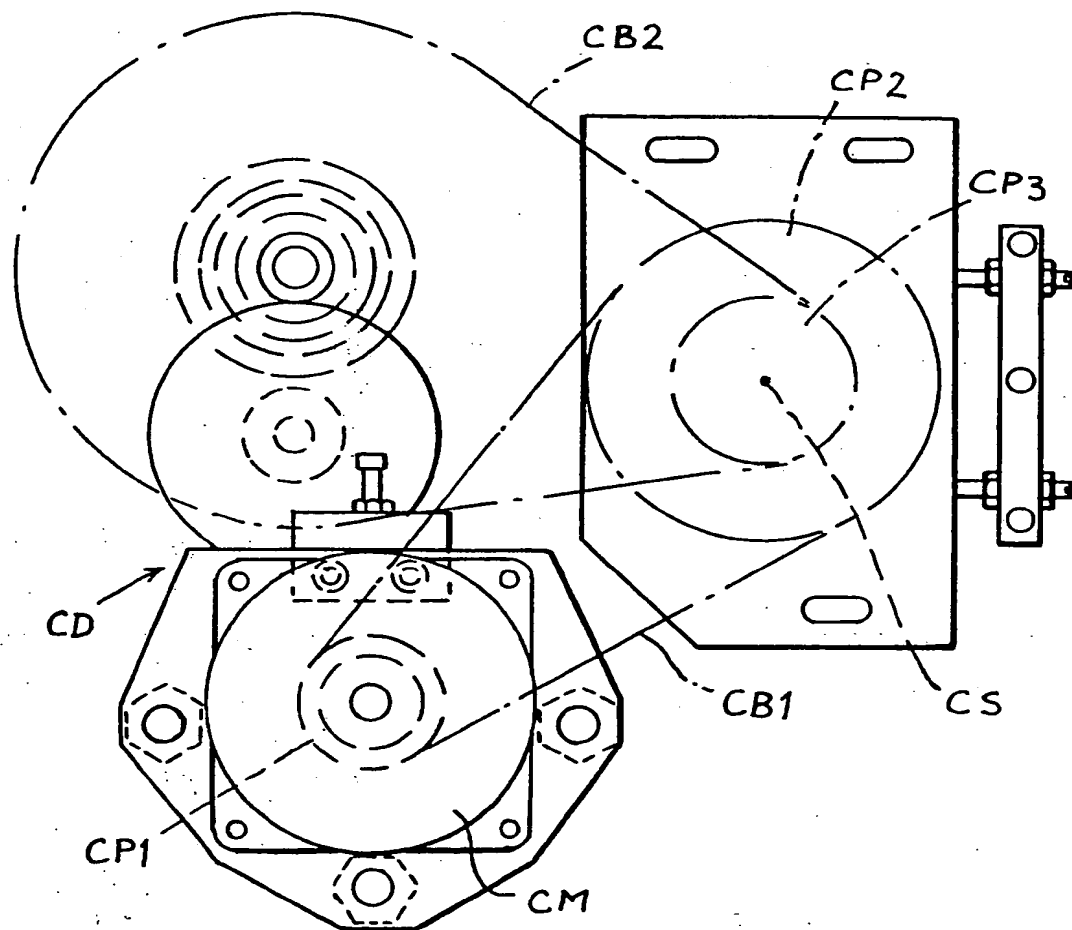


Fig.10

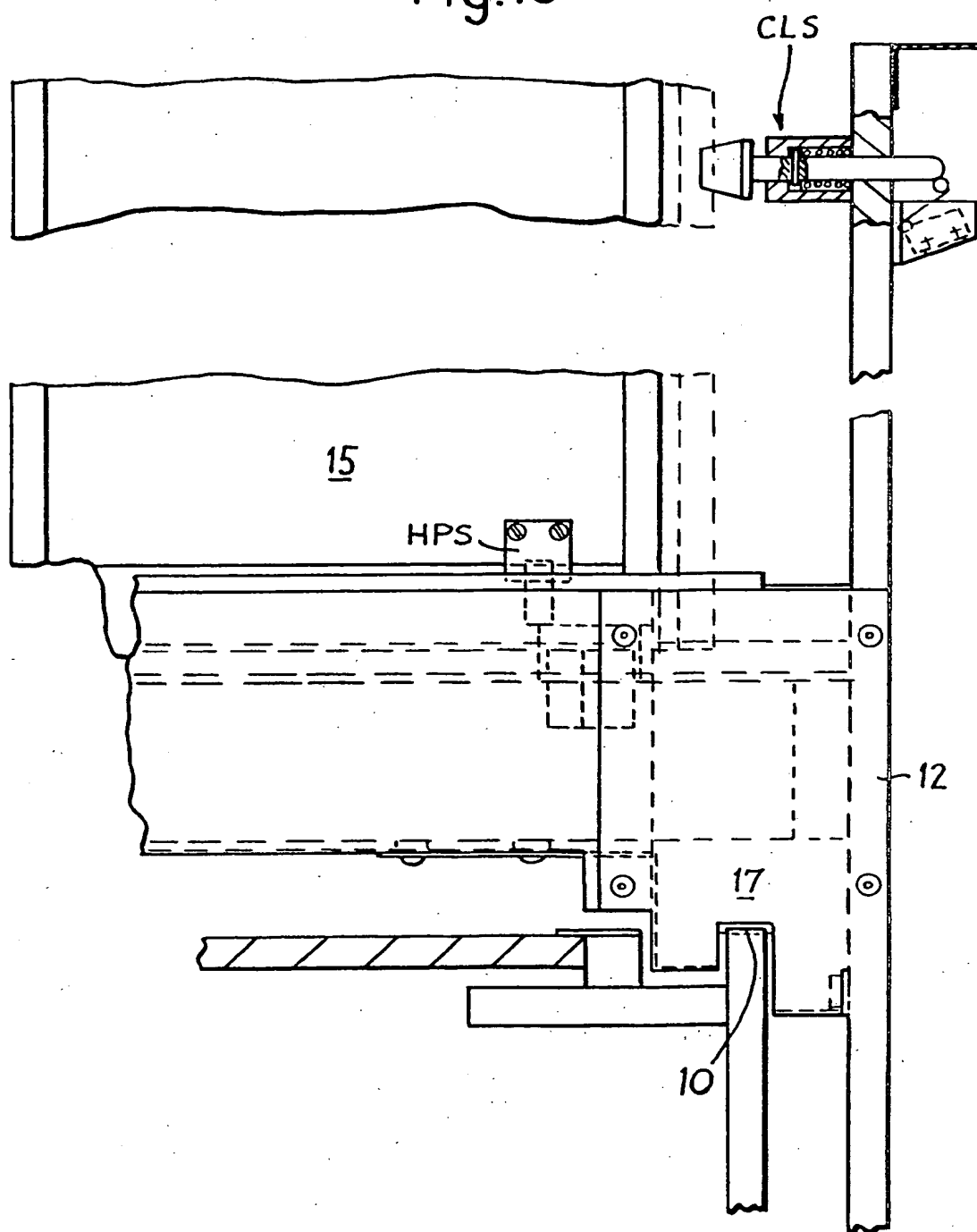
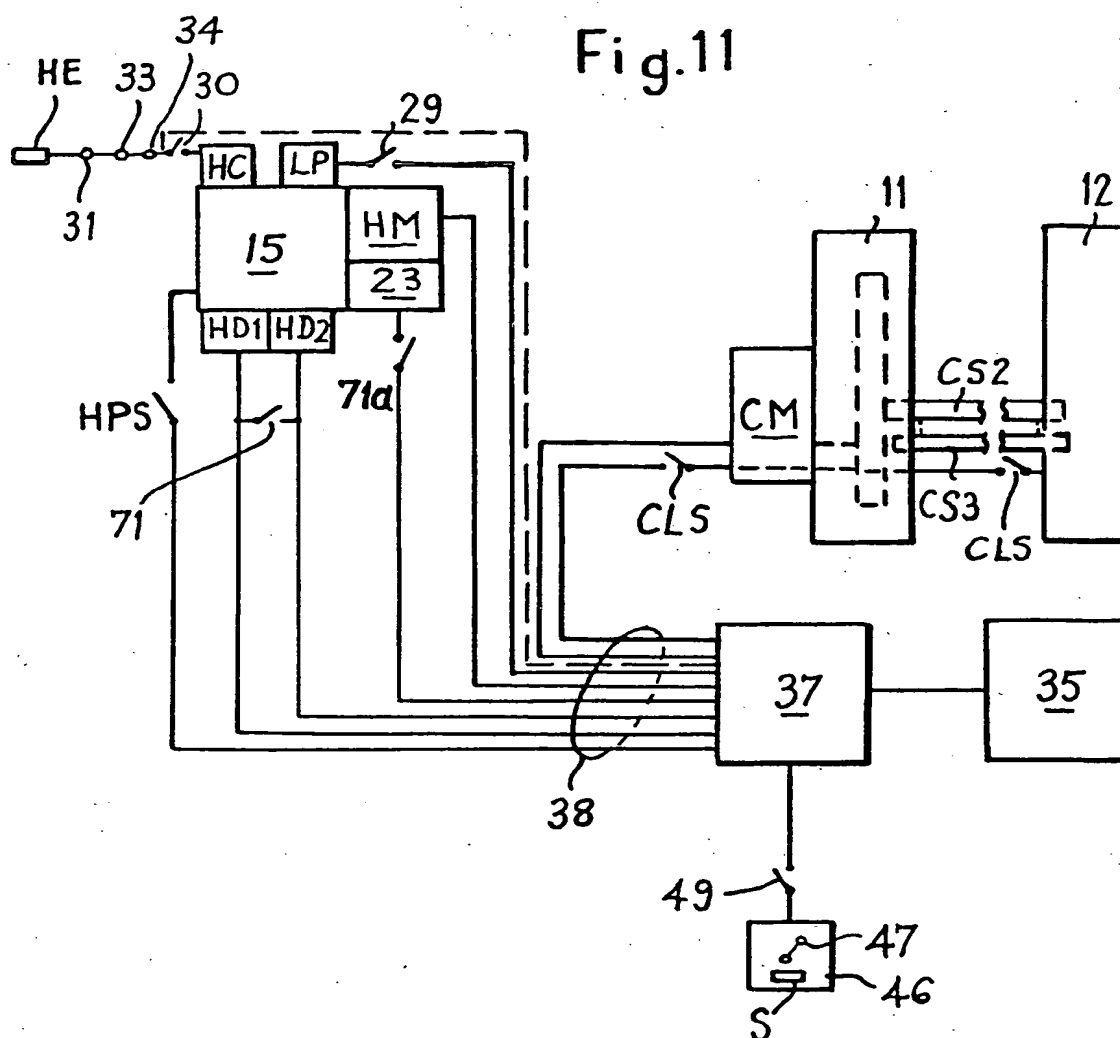


Fig.11



12/12

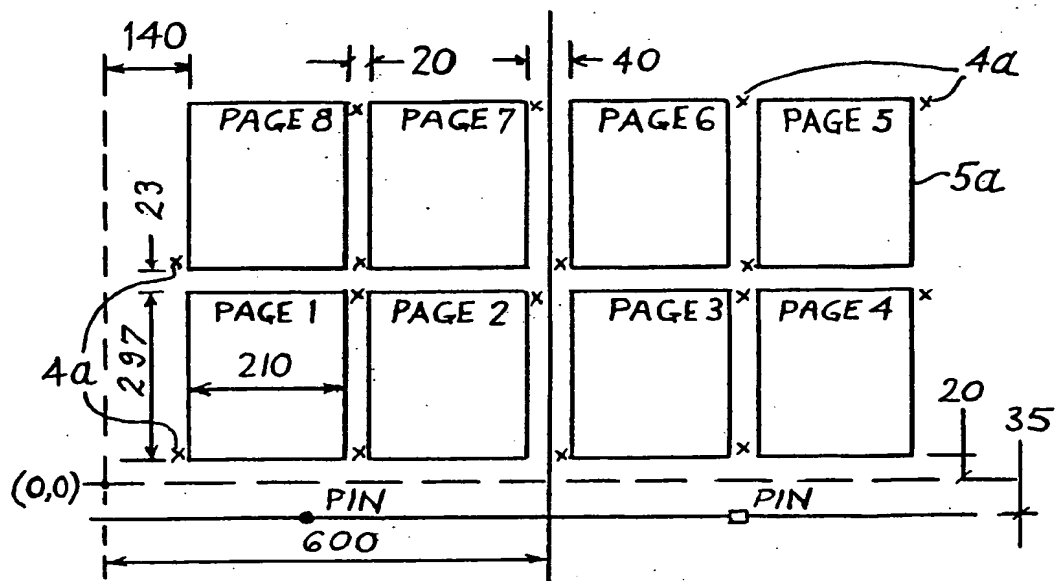


Fig.12

## SPECIFICATION

**Improvements in or Relating to the Production of Graphic Material for Use in Colour Printing or Like Processes**

- The present invention relates to the production of graphic material for use in the graphic arts such as printing and sign making and more particularly for use in colour printing or like processes. 5
- Apparatus and methods are already known for producing registration of graphic material comprising individual sets of colour separation or like component records where a plurality of different sets of such records is to appear throughout the areas of a plurality of carrier sheets, one carrier sheet for each group of separation components representative of one colour.
- One such apparatus and method is disclosed in the Applicant's U.K. Patent Specification No. 1,128,207 the subject matter of which is incorporated in the specification of the present application by reference. No. 1,128,207 comprises a surface for receiving work in the form of a colour set or sets and one or more backing sheets, holding means for securing the materials in relation to said surface and a drilling machine mounted to move with two degrees of movement above said surface. Such a drilling machine or head has a hollow drill for forming registration holes in the colour sets or like components. 10
- Another known apparatus comprises a punching machine or head provided with a hollow punch for forming the registration holes, instead of the drilling machine or head. The head of either of said apparatus is movable manually over the work supporting surface and may be adapted, in addition to forming registration holes using a forming tool such as a drill or punch, to carry out marking out using a marking out tool e.g. a scribe, pen or pencil, and mask forming using a mask forming tool having a cutting knife such as a scalpel blade, with the registration hole forming, marking out and mask forming tools also being moved manually into and out of contact with the work. Another form of mask forming tool utilizing a heated point is disclosed in the specification of our co-pending British Patent Application No. 8301710 filed on 21st January, 1983, and the Application filed on the same day as this 15
- Application both entitled "Improvements in or Relating to the Production of Lines of Separation in a Sheet or other Member", the subject matter of which is also incorporated into the specification of the present application by reference. 25
- The problems involved with such apparatus are that the particular tool used has to be manually moved over the work surface and lifted and lowered with respect to the work surface which can involve time and there may be errors even with skilled personnel. 30
- Accordingly, the main object of the present invention is to produce graphic material by carrying out at least one of the functions of forming registration holes, marking out and mask forming in a less costly, less labour intensive, less time consuming, more accurate manner than has hitherto been possible and in a controlled fully automated manner.
- To this end, and from one aspect, the present invention consists in apparatus for use in the production of graphic material for example for use in colour printing, sign making and like processes, in which a head or other support member is movable with at least two degrees of movement over a supporting surface for work such as at least one sheet or other member, characterized by means connectible to the head for use in carrying out at least one of the functions of registration hole forming, marking out and mask forming, drive means for effecting the movement of the head over said surface, means for controlling said head movement, including a computer, drive function means connected to said computer and to said head drive means and a computer programme for programming said computer to control the movement of the head to perform at least one of said functions of registration hole forming, marking out and mask forming in a pattern dictated by the programme to produce the required graphic material. 35
- By means of the invention, not only is the graphic material produced in a simple, convenient, and time reducing manner but product quality can also be improved.
- Although the head may be mounted to move with more than two degrees of movement, Applicants have found that two degrees of movement is satisfactory.
- The drive means is preferably of the positive type and advantageously comprises electrical motors connected to rack and pinion means or, alternatively, lead screw drives. 40
- The computer may be of any suitable kind which is commercially available on the market and advantageously has a processing function e.g. performed by microprocessors. However, in order that the registration hole forming, marking out and mask forming functions are fully automated in a preferred embodiment, the computer also has a relay function or is connected to relay function means connected to electrical actuating means such as an electric motor for lifting and lowering a registration hole forming tool and/or to electrical actuating means for lifting and/or lowering a marking out or mask forming tool. In the case where the registration forming tool is a drilling tool, the relay function will also activate a drive motor for the drilling tool. 45
- In a preferred embodiment of the present invention, the head is mounted to move along a guide extending in one direction over said surface, the guide being fixed at its opposite ends to respective carriage means by means of which the head can be moved in a direction at right angles to the direction of movement of the head along the guide. Thus, the head is movable along X and Y co-ordinates. 60
- The drive motors and electrical actuating means may be electrically operated by an activating

signal from the computer at the requisite time controlled by the programme. The electrical actuating means for lifting and/or lowering the marking out and mask forming tools is conveniently constituted by a solenoid as described in the specification of our aforementioned British Patent Application No. 8301710.

5 The solenoid preferably performs a lifting action with the lowering action being carried out by resilient means. 5

In order to provide visual input of the patterns stored in the particular computer programme and to permit pattern selection, the computer preferably includes a visual display unit which, when the programme is fed into the computer and keyed in, the patterns of registration holes, marking out lines or separation lines which are to be made in the work are displayed on the screen of the visual display unit. 10 10

Thus, in apparatus constructed in accordance with the invention, when the computer has been fed with a programme appropriate for registration hole forming, marking out or masking forming, the programme keyed in, and the appropriate pattern selected, using the visual display unit, the head will be moved automatically in the selected pattern dictated by the programme and the tool being used will be brought automatically into and out of contact with the work. 15 15

Preferably, also, the computer has a programme recording facility so that a particular selected pattern devised for a particular purpose can be recorded on a blank tape disc, or card, and used again.

From another aspect, the present invention consists in a method of producing graphic material for example for colour printing, sign making and like processes, said method comprising carrying out at least one of the functions of registration hole forming, marking out and mask forming, by driving a registration hole forming means, marking out means or mask forming means over a work supporting surface and in contact with the work, and controlling the driven movement of the particular means by means of a computer which is programmed by a computer programme whereby at least one registration hole, one marking out line, or line of separation is formed in the work in a pattern dictated by the programme to produce the required graphic material. 20 20 25 25

The term "graphic material" as used herein includes within its ambit work on which at least one of the operations of registration hole forming, marking out and mask forming have been carried out.

In order that the invention may be more readily understood, reference will now be made, by way of example to the accompanying drawings, in which:— 30 30

Fig. 1 is a diagrammatic perspective view of apparatus for producing graphic material and incorporating a registration hole forming tool,

Fig. 2 shows the apparatus of Fig. 1 incorporating a mounting arrangement supporting a marking out tool, with the registration hole forming tool having been removed,

35 Fig. 3 shows the apparatus of Fig. 2 showing a mask forming tool supported in the mounting arrangement instead of the marking out tool, 35

Fig. 4 is a detailed side elevation to an enlarged scale of that part of the apparatus of Fig. 2 or Fig. 3 showing the mounting arrangement and marking out mask forming tool supported therein,

40 Fig. 5 is a part-sectional side elevation of a movable head and work table forming part of the apparatus of Fig. 1, 40

Fig. 6 is a developed view of the drive system for the head,

Fig. 7 is a true view of the head drive system taken along the arrow VI of Fig. 6,

Fig. 8 is a part-sectional side elevation of two carriages forming part of the apparatus of Fig. 1, with the drive system of one carriage, the left hand as illustrated being shown in developed form,

45 Fig. 9 is a true view of the left hand carriage drive system, taken along the arrow VIII of Fig. 8, 45

Fig. 10 is a detailed side elevation of part of the apparatus of Figs. 1 to 3, and

Fig. 11 is a block diagram of the electrical control circuit of the apparatus of Figs. 1 to 3, and

Fig. 12 shows a layout constructed from a computer programme.

Referring to Figs. 1 to 3 of the drawings, the apparatus comprises a work table 1 having an illuminated work supporting surface which is conveniently formed of a translucent plastics material such as polyvinyl chloride or polyethylene resting on a light transmitting glass platform. Work in the form of a set of four colour separations 3 and backing foils (Fig. 1) to be drilled with registration holes by a hollow drilling tool 4, of a plastics backing foil 3a (Fig. 2) which has been drawn up by a drawing pen 5 and of a bilaminated plastics masking sheet 3b (Fig. 3) comprising photographically opaque and transparent layers in which lines of separation have been produced in the upper photographically opaque layer by a mask forming (cutting) tool 6, supported on the work surface 2. 50 50 55 55

The work table 2 has a front member 7 on which are positioned an on/off switch 7a, for the work table, an indicator light 7b, a brightness control knob 7c for work surface illumination and four fuses 7d and side members 8 which are disposed at opposite ends respectively of the work surface and which support respective parallel racks 9 and 10. Two carriages 11 and 12 which are rigidly interconnected by means of a lower elongate support structure 13 and an upper tubular guide 14 extending at right angles to the racks 9, 10 and mounting a movable head 15 carrying the appropriate tools 4, 5 or 6 mounted for synchronous movement along the racks 9 and 10 by a carriage drive system to be described and including an electric motor. The left-hand carriage 11 is wider than the right-hand carriage 12 to carry the major part of the carriage drive system. Castings 16 and 17 accommodate 60 60 65 65

respective freely rotatable pinion gears 16a, 17a which are mounted on stub shafts in bearings and which together with driven pinion gears CG2 and CG2' of the carriage drive system engage with the racks 9 and 10 respectively and support the carriages 11 and 12 on the racks. Suitable known means (not shown) maintain the carriages in positions which are fixed with respect to the racks 9 and 10 and work surface 2.

The head 15 is driven along the guide 14 by means of another drive system to be described and including an electric motor carried by the head and including a gear train pinion gear which engages with a rack 18 mounted on the support structure 13. Thus, the head can be driven over the work surface 2 with two degrees of movement, i.e. along X and Y co-ordinates. The head 15 cannot be moved manually.

The electric motors of the head and carriage drive systems may be stepper motors, linear motors or D.C. servo-motors.

Referring more particularly to Fig. 1, the hollow drill 4 is removably mounted in a drill chuck 19 which is rotatable by means of an electric motor HD1 (Fig. 11) mounted in the head 15. The drill chuck 19 is rotatably mounted in bearings in a vertical guide tube 20 which, in turn, is mounted for vertical downwards, and upwards movement in suitable bearings by another electric motor HD2 (Fig. 11) accommodated in the head to bring the drill into and out of contact with the colour set 3. Suitable switching means (not shown) may be provided to control the downward movement of the drill so that the chuck 19 is raised when the drill 4 has drilled through the lowest member of the work 3.

In an open-bottomed recess 21 in the front of the head 15, there are a pair of shouldered screws 22 projecting from the rear wall of the recess for mounting on the head a mounting arrangement 23 to be described (Figs. 2 and 3) for the drawing pen 5 (Fig. 2) or mask cutting tool (Fig. 3). The rear wall of the recess also has an aperture therein in which is an actuating member 24 of a microswitch 71 (Fig. 4) for cutting out the drill motors HD1 and HD2 when the mounting arrangement 23 is mounted on the head. A socket 25 is provided in the front face of the head 15 for receiving the plug of an electrical lead 26 (Figs. 2 and 3) for energizing an electrically actuatable lifting means to be described for the mounting arrangement 23.

The head 15 has, at its top, a control cabinet 27 which is also illustrated in Figs. 2 and 3, and which houses an electrical circuit for a light projecting means LP (Fig. 11) carried by the head and a heating circuit HC (Fig. 11) for the mask cutting tool (Fig. 3). A suitable light projecting means is disclosed in the specification of our British Patent No. 1,536,135 the subject matter of which is incorporated into this specification by reference. Such a light projecting means projects a single beam of light onto a point beneath the head 15 and axially in line with the drill tip so as to produce a spot of light on the surface of the work 3 at the point to indicate the desired working position for the drill tip to touch the work. A clamping foot 28 is mounted for vertical movement with respect to the head 15 so that after the head 15 is positioned, the clamping foot can be moved downwardly by means of a suitable known connecting mechanism in advance of the drill 4 to clamp the work 3 against the work surface 2 prior to and during drilling of the registration holes. Thus, the front panel of the cabinet 27 has push-button on/off switches 29 and 30 for the light projecting means and mask cutting tool respectively.

The mask cutting tool 6 is of the kind disclosed in our aforementioned British Patent Applications which has a heated point to form lines of separation in the work to cut a mask. Such a mask cutting tool is particularly suitable for the apparatus of the present invention as the tool itself does not have to be rotated in order to form lines of separation involving curves. The cabinet 27 has a socket 31 for the heating circuit HC into which socket is plugged a lead 32 (Fig. 3) connected to an electrical heating element HE (Fig. 11) in the tool 6. An indicator light 33 is provided on the cabinet 27, which lights up when the switch 30 is pressed to the on position and the cabinet has a temperature control knob 34 for regulating the temperature of the heating element HE to suit the material of the work. If the function required for the apparatus is that of registration hole forming then the control cabinet 27 could be omitted and the switch 29 for the light projection means, if desired, positioned say on the front panel 7 of the work table 2 or on the head itself.

The apparatus illustrated in Figs. 1 to 3 further comprises a microcomputer which is generally indicated at 35 and which is mounted on a trolley 36 at one side of the work table 1. The computer 35 is connected via a motor interface control unit 37 acting as a drive function which may be included in the computer, a multi-lead cable 38 to, inter alia the drive systems for the head 15 and carriages 11, 12, drill motors and electrical actuating means for the mounting arrangement 23. The electric motors for the drive systems of the head 15 and carriages 11, 12 are controlled by programmed pulsed digital output from the computer 35.

The microcomputer 35 comprises a keyboard terminal 39 visual display unit (VDU) 40 and two MPI disk drive units 41 and 42 and is built around the Z80A microprocessor. At the rear of the computer 35, there are mounted not visible on/off switches including a computer power switch, a keyboard/terminal switch and a VDU switch. The computer 35 can be operated in an environment of up to 45°C and 90% non-condensing humidity. Electricity requirements are single phase supply of, nominally 240V or 115V, 50Hz. Consumption is 1kW. The standard internal memory of the computer 35 is 64K (dynamic) RAM with a further 2K (static) RAM used for the character set and 2K EPROM for

the bootstrap and simple monitor functions. The Operating Systems/Programme disks 43 (Fig. 1) and 44 (Fig. 2 and 3) containing the computer programmes CRD for colour registration drilling and MC/D for mask cutting and drawing respectively are double-sided, double density  $5\frac{1}{4}$ " floppy disks which have a capacity of 400K each.

5 The keyboard 39 has a standard QWERTY layout with 96 keys producing full ASCII codes. There is a numeric key pad and a separate reset key. The VDU 40 is a 12" video monitor and includes brightness and contrast controls. Characters are presented on an 8x10 dot matrix with 80x25 screen formats in normal mode. 5

The apparatus includes, optionally, a hand control unit 46 for random drilling, shown as supported on the trolley 36 and having a lead 47 which can be plugged into the motor controller interface unit 39. The unit 46 also has a joy stick control lever 48, by means of which the head 15 can be moved anywhere over the work surface 2 and incorporates a switch 49 to enable the head to move at two different speeds and a push button 49a for actuating the drill when the head is in the desired position over the work 3. 10

15 Referring more particularly to Figs. 2, 3 and 4, the drawing pen 5 and mask cutter 6 are shown in full lines and chain lines respectively in Fig. 4 and are supported in the mounting arrangement 23 on a locating flange or shoulder 50. The pen has a ball point 51 and the mask cutter has a tool member 52 which is heated by the heating element and terminates in a point which is at the apex of a cone. The mounting arrangement 23 is generally of T shape with the generally horizontally disposed bar 53 of the T locating in the recess 21 by means of a pair of apertures which align with the shouldered screws 22 so that the screws pass through the apertures with two milled edged nuts such as 54 engaging the screws 22 to secure the mounting arrangement rigidly on the head 15. The shoulders such as 56 on the screws 22 located in larger diameter apertures in the bar 53 and serve to guard against the screws 22 being bent out of alignment during mounting. The generally vertically disposed leg 57 of the T supports a pivoting lever 58 having a clamping arm 59 and an actuating arm 60 projecting forwardly and rearwardly respectively of the pivot 61 and of the leg 57. The clamping arm 59 has a central split (not visible) to form two resilient clamping members with an aperture in the split being provided for receiving a portion of the pen 5 or mask cutter 6 beneath the location shoulder 50 so that when a milled-edged nut is tightened on a screw 63, the pen 5 or mask cutter 6 is securely clamped in position on the clamping arm 59. Reference 59 is a transparent protector. 15 20 25 30

A spring loaded adjuster 64 is mounted on a bracket 65 on the leg 57 and bears on the clamping arm 59 at a location intermediate the pen 5 or mask cutter 6 to bring the point of the pen or mask cutter, as the case may be into contact with, and maintain the point in contact with, the surface of the work 3a, 3b on the work surface 2. The force exerted by the compression spring 66 of the adjuster 64 may be varied by means of the knob 67. 35

In order to lift the point of the pen or mask cutter as the case may be out of contact with the work 3a or 3b, the electrical actuating means already referred to is constituted by a solenoid 68 which is mounted on the rear of the leg 57 and has an armature 69 which, when the solenoid is energized, is extended and pushes the actuating arm 60 downwards. A compression spring 70 exerting a weaker force than, and acting in opposition to, the spring 66 of the adjuster 64 acts to cushion the downward movement of the clamping arm 59 when the solenoid 68 is de-energized to commence a drawing or mask cutting operation and has a counterbalancing effect to impart a degree of resilient contact of the pen or mask cutter point with the work 3a, 3b during movement of the head 15. 40

Fig. 4 also shows the microswitch 71 for cutting out the drill motors when the mounting arrangement is secured to the head 15. 45

Referring to Figs. 5 to 7, the drive system HD for the head 15 is mounted on a rear portion of the head and includes the stepper motor HM, and belt and pulley and gear trains, with the gear train being housed in a gear box 72 (Fig. 5).

A removable casing 15a covers that portion of the drive system which is not enclosed by the head. The pulleys which are indicated by the references HP1, HP2, HP3, and HP4 are fixed to their respective illustrated shafts which are rotatably supported in appropriate bearings as illustrated in the developed view of Fig. 5. The output shaft of the stepper motor HM is connected to the pulley HP1 which drives the pulley HP2 through a belt HB1. The pulleys HP2 and HP3 are fixed on an idler shaft HS1 with the pulley HP3 driving the pulley HP4 fixed on the input shaft HS2 of the gear box 72. A gear HG1 is fixed on the shaft HS2 and meshes with a pinion gear HG2 which is fixed on a shaft HS3 and which, in turn, meshes with the rack 18, mounted on a rail 74. 50 55

The rail 74 is rigid with an elongate flat member 75 fixed to a square-section beam member 76, the members 75 and 76 forming part of the support structure 13. At its rear side, the support structure 13 further includes an elongate support member 77 bolted to the beam 76 and carrying in its central region a centering device 78 for a rotatable shaft CS2 and supported in a bracket 79 bolted to the support member 79. Shafts CS2 and CS3 form part of the drive system for the carriages 11 and 12. 60

The carriage drive system CD for driving the carriages synchronously along the racks 9 and 10 will be described with reference to Figs. 8 and 9. The carriage driven system comprises a stepper motor CM, a belt and pulley train and gear train, all of which are identical to the stepper motor HM, belt and pulley train and gear train for the head 15. Thus, the head and carriage belt and pulley and gear trains 65

have identical ratios. The pulleys and gears are fixed to the illustrated shafts which are rotatably supported in appropriate bearings as illustrated in Fig. 8. A pulley CP1 is fixed to the output shaft of the motor CM and drives a pulley CP2 fixed on an idler shaft CS1 via a belt CB1. A pulley CP3 is also fixed on the idler shaft CS1 and drives a pulley CP4 fixed on shaft CS2. A gear CG1 is fixed on the shaft CS2 outside the carriage 11 and meshes with the pinion gear CG2 fixed on the shaft CS3 and engaging with the rack 9. In order to transfer the drive from the carriage 11 to the carriage 12 such that the two carriages are driven in synchronism, the shafts CS2 and CS3 extend parallelly for the full length of the work surface and into respective bearings in the carriage 12. Adjacent the carriage 12, the shaft CS2 has fixed thereon a gear CG1' which corresponds to the gear CG1 and the shaft CS3 has fixed thereon a pinion gear CG2' which corresponds to the pinion gear CG2 and which meshes with the gear CG1' and with the rack 10.

Referring now to Fig. 10, the carriages 11 and 12 are provided with respective limit microswitches CLS (only one shown) for the carriage 12 which are connected between the motor interface control unit 37 of the computer 35 and the carriage drive motor CM to stop the movement of the carriages in either direction along the racks 9 and 10 just before the carriages reach the ends of their paths of movement therealong. Also, the head 15 is provided with a proximity microswitch HPS which is connected to the computer 35 via the motor interface control unit 37 and which engages with the head guide 14. The microswitch HPS provides the computer with a signal which is representative of the position occupied by the head 15 at the start of a drilling, drawing or mask cutting operation.

As an alternative to the heating circuit HC (Fig. 11) being switched on mechanically by the switch 30 and the temperature of the heated point of the mask cutting tool being controlled by the temperature control knob 34, the computer 35 can be connected to the heating circuit via the motor interface control unit 37 and an electrical switch 30 as indicated by the dashed lines in Fig. 11. Thus, the computer 35 will switch on the heating circuit HC by means of an electrical signal to switch 30 and will also, preferably, control the relationship between the temperature of the heated point of the tool 6 and the velocity of the head 41 moving the tool 6. The computer can, therefore, regulate both tool temperature and velocity to increase the temperature when being moved at higher speeds, say for straight lines, and to decrease the temperature when the tool point has to be moved in tight arcs and to produce corners, say in rectangles and triangles. The temperature control knob 35 is desirably included to set the temperature initially to the value for the particular material of the work. These temperature controlling factors will be built into the mask cutting/drawing programme to be described.

When the point of the tool 6 is at the temperature set by the control knob 35, the computer sends an electrical signal to actuate a switch 71a for the electrical actuating means 23 which will de-energize the solenoid of the electrical actuating means 23 so that the heated point of the tool 6 is brought into contact with the work 3b. At the end of a mask cutting operation, the computer will send another signal to the switch 71a so that the solenoid is energized and the tool point is brought out of contact with the work 3b. The electrical actuating means 23 will similarly be controlled by the computer when a marking up operation is being carried out using the pen 5. The computer 35 will also send electrical signals to the drill motors HD1 and HD2 to start and stop these motors when a drilling programme is being carried out.

In order to operate the apparatus illustrated in Figs. 1 to 3, the apparatus is first set up for drilling drill holes 4a (Fig. 1), drawing up with page shape lines 5a and shape lines 5b (Fig. 2) or mask cutting lines of separation 6a (Fig. 3) with the appropriate floppy disk 44 for mask cutting/drawing MC/D or 43 CRD for drilling registration holes being inserted into the drive unit 41, its data being entered "interactively" into the computer's internal memory, via the keyboard 30, in response to programme commands displayed on the VDU 40. This data, when compiled can also be stored on a floppy disk which has been inserted in the drive unit 42 under a chosen file name, for future recall. Data is transcribed by the computer into electrical pulses which are fed, via the Motor Controller Interface unit, to the two stepper motors that move the carriage and head. Both axes step at increments of 20 microns (0.020mm) thereby enabling the head to be accurately positioned to any point within the working area of the table.

The Mask Cutting and Drawing programme MC/D allows the operator to construct a layout on the VDU 40. Up to 64 pages can be positioned within a layout each page being rectangular and of any size up to the maximum dimensions of the layout, —1200x900 mm on the size 4 machine and 1650x1150 mm on the size 7. Regular geometrical shapes up to a maximum of 200, can be entered into each page. The operator specifies the size and position of each page within the layout and the size and position of the shape, or shapes, within the page. The standard shapes that can be produced are circles, rectangles with square corners, ellipses, triangles, diamonds, arcs, straight lines and register marks. All the shapes can be rotated to any desired angle within the page, and can be surrounded with a variable width border.

As pages and shapes are created they can be displayed on the VDU for verification prior to outputting on the work table for drawing or mask cutting. Pages can also be edited through the terminal before outputting, including such functions as moving or deleting pages and shapes, changing page numbers and repeating pages. Compiled layouts can be recorded on File Library (FL) disks inserted into the drive unit 42 and recalled at any time for future re-runs. Up to 40 complete layouts

selected from the MC/D of any complexity, can be stored on one FL disk. If blank standard page formats such as A3, A4 etc. are used regularly then they can be stored on an FL disk to speed up page construction.

Special shapes, logos or irregular outlines can be built into the MC/D programme if desired.

To give an example of how a layout is produced using the mask cutting/drawing programme MC/D, reference will now be made to Fig. 12, which shows a 8 page A4 size layout, and the Table set out below.

The following instructions should first be carried out.

1. Switch on the microcomputer.

2. Place the mask cutting and drawing systems disk into Drive 41 and close the hatch cover.

3. Key letter B.

4. When the operating system prompt (A) appears, type PROTO, followed by the Key (ENTER). The title page will appear. Type (ENTER) to continue.

5. Then the following instructions should be entered.

TABLE

Instruction	V.D.U. Display	Remarks
Key 2	Select Menu 2 Page Menu/Drill Holes .....	Select Menu comprises 9 options. Type 2 to enter the PAGE MENU.
Key 5	Page Menu ..... 5 Add Page/Add Drill Hole	Select option 5 of the PAGE MENU (ADD PAGE/Add Drill-Hole)
Then input:— 140 (ENTER) 20 (ENTER) 210 (ENTER) 297 (ENTER)	5. ADD PAGE/Drill Hole Distance from Left of Layout Distance from bottom of Layout Width Height	Page 1 dimension in millimeters.
370 (ENTER) 20 (ENTER)	Distance from left of Layout Distance from bottom of Layout	Page 2 dimension
620 (ENTER) 20 (ENTER)	Distance from left of Layout Distance from bottom of Layout	Page 3 dimension
850 (ENTER) 20 (ENTER)	Distance from left of Layout Distance from bottom of Layout	Page 4 dimension
850 (ENTER) 340 (ENTER)	Distance from left of Layout Distance from bottom of Layout	Page 5 dimension
620 (ENTER) 340 (ENTER)	Distance from left of Layout Distance from bottom of Layout	Page 6 dimension
370 (ENTER) 340 (ENTER)	Distance from left of Layout Distance from bottom of Layout	Page 7 dimension
140 (ENTER) 340 (ENTER)	Distance from left of Layout Distance from bottom of Layout	Page 8 dimension

Each page must be entered separately. If shapes are required within the pages a shape menu is available from the MC/D programme to select and add the required shapes. As page 1 is defined in width and height this information does not require repeating for pages 2 to 8.

The colour register drilling programme CRD is for precise registering of colour sets used in standard format work such as books, magazines, cartons or postcards where constant size image areas are repeated on the layout. The drilling programme enables the operator to specify the number and position of register holes (usually 2) relative to each of the image areas and then to step these to user-defined repeat positions in the layout, if required. Once the data has been compiled using a similar set of instructions to those for the MC/D programme it can be displayed on the VDU 40 for verification

or reading. (please see Instructions to press keys 2 and 5 and input for add drill hole in the above Table and Fig. 12). The register holes 4a (Fig. 12) can then be automatically drilled in their correct positions in the layout to an accuracy of 0.05 mm or less. The colour separations 3 held together on a film location bar 45 are similarly drilled on the table with the same matching computer generated register holes. Again, as with the MC/D programme the programmes selected from the CRD programme can be recorded on an FL disk inserted into the drive unit 42 and recalled at any time for future re-runs.

In order that the mask cutting/drawing and drilling functions of the apparatus of Figs. 1 to 3 are fully integrated, in accordance with an important preferred feature of this invention, the software has been designed to allow page impositions, constructed by the MC/D or CRD programme and stored on an FL disk, to be accessed by either of the systems disk. It is possible, therefore, to add registration holes directly to the stored image (page areas, created by the MC/D programme, without having to re-enter the page co-ordinates. Similarly, pre-drilled page layouts, created by the CRD programme, can have shape information added to them so that, for instance, masks can be accurately aligned with the position of the registered colour sets in the layout.

It should be appreciated for a mask cutting operation, there is an output command from the computer to cut the selected or compiled shapes only (not the page boundaries) full size in the work on the work table.

Separate, off-line, terminals can be supplied for independently producing programmes on floppy disks. This facility is extremely useful as programmes can be originated in studios etc. remote from the apparatus without interfering with the outputting of the one-line terminal. Software supplied originally with each apparatus is encoded to give data protection and will therefore only operate on that particular machine. If off-line terminals are being used then the data produced by them will also be encoded so that the disks can only be used on the original on-line terminals.

Either the mark/space ratio, frequency or amplitude of the electrical signals emitted by the computer 35 may be used to control the velocity of the head and carriages and the temperature of the heated point of the tool 6.

It will be appreciated that various modifications may be made without departing from the scope of the invention as defined in the appended claims. For example, the MC/D and CRD programmes could be combined on one floppy disk, with computers having a greater capacity than the microcomputer described. The programmes can be stored in cassettes, punched tape or card instead of on floppy disks.

#### CLAIMS

1. Apparatus for the production of graphic material, in which a head or other support member is moveable with at least two degrees of movement over a supporting surface for work, characterized by means which is connectible to the head for use in carrying out at least one of the functions of registration hole forming, marking out and mask forming, drive means for effecting the movement of the head over the work surface, means for controlling said head movement, including a computer, drive function means connected to, or incorporated in, said computer and connected to said drive means, and a computer programme for programming said computer to control the movement of the head and thus of said registration hole forming means, marking out means or mask forming means to form at least one registration hole, marking out line or mask forming line of separation in the work in a pattern dictated by the programme to produce the required graphic material.

2. Apparatus as claimed in claim 1, characterized in that the head is mounted to be driven by the drive means along an elongate guide with one degree of movement, said guide being supported on two carriages and in that said carriages are driven in synchronism by the drive means at right angles to the direction of movement of the head with another degree of movement.

3. Apparatus as claimed in claim 2, characterized in that the two carriages are supported on two racks extending at right angles to the direction of the guide by means of respective pairs of pinion gears which engage with the two racks respectively and of which one of the pinion gears of each pair are idler gears and the other of the pinion gears of each pair are driven and form part of the carriage drive system.

4. Apparatus as claimed in claim 2 or 3, characterized in that the head drive means includes a pinion gear which engages with a rack extending parallel to the head guide.

5. Apparatus as claimed in any of claims 2 to 4, characterized in that the head and carriage drive means comprise respective identical electric motors which are connected to said drive function means and which are controlled by electrical signals from said computer.

6. Apparatus as claimed in claims 3 to 5, characterized in that the head and carriage electric motors are connected to respective trains of drive elements having identical ratios between the elements of the respective trains.

7. Apparatus as claimed in claim 6, characterized in that the carriage motor and the majority of the carriage drive elements are supported by one of the carriages and in that other ones of the carriage drive elements are rotatable shafts which extend between the two carriages in parallel with the head guide, with the shafts being geared together adjacent the two carriages by respective further ones of the carriage drive elements which have an identical ratio to one another.

8. Apparatus as claimed in any one of claims 5 to 7, characterized in that limit switch means is connected to the drive function means for sensing when the carriages are approaching the ends of their paths of movement and operative to send a signal to the drive function means whereupon the computer sends an electrical signal to the carriage motor to stop the movement of the carriages.

5 9. Apparatus as claimed in any one of claims 1 to 8, characterized in that the head carries a switching means which is connected to the computer to provide the computer with a signal representative of the position occupied by the head at the start of at least one of a registration hole forming, marking out and mask forming operation. 5

10 10. Apparatus as claimed in any one of claims 1 to 9, characterized in that the apparatus includes a chuck for supporting the registration hole forming means which is constituted by a drill, said chuck being rotatable by a first electric motor and being movable downwardly and upwardly by means of a second electric motor to bring the drill into and out of contact with the work, said drill motors being connected to said drive function means and being controlled by electrical signals from the computer. 10

15 11. Apparatus as claimed in any one of claims 1 to 10, characterized by a mounting arrangement which is adapted to be mounted on the head and to support the marking out means or a mask forming means, and in that the mounting arrangement includes electrical actuating means which is connected to said drive function means by a switching means operated by an electrical signal from the computer to cause the electrical actuating means to move the marking out means or mask forming means into and/or out of contact with the work. 15

20 12. Apparatus as claimed in claims 10 and 11, characterized in that the head carries a switching means which is actuated by the action of mounting the mounting arrangement on the head to disconnect the drill motors from operation by the computer to prevent any inadvertent operation of the drill motors during a marking out or mask forming operation. 20

25 13. Apparatus as claimed in claim 11 or 12, characterized in that the electrical actuating means is a solenoid having an armature and which is energized when the switching means is operated by the signal from the computer thereby causing the armature to act on one end region of a pivotable lever to lift the marking out means or masking forming means which is carried by another end region of said lever out of contact with the work. 25

30 14. Apparatus as claimed in claim 13, characterized in that resilient means, which act in opposition to the action of the armature, are provided for bringing the marking out means or mask forming means into contact with, and for maintaining the marking out means or mask forming means in resilient contact with, the work. 30

35 15. Apparatus as claimed in claim 14, characterized in that another resilient means is interposed between the solenoid and the lever, said another resilient means acting in opposition to the force exerted by the first mentioned resilient means to cushion the movement of the marking out means or mask forming means into contact with the work and having a counter-balancing effect. 35

40 16. Apparatus as claimed in any one of claims 1 to 15, characterized in that the computer has a visual display unit to enable a selection of at least one of the pattern of registration holes from a registration hole forming programme and marking out lines and masking lines from a marking out and mask forming programme and to display the selected pattern which is to be formed on the work. 40

17. Apparatus as claimed in claim 16, characterized in that the computer has a recording facility to enable the selected pattern to be recorded on blank programming material for future use.

45 18. Apparatus as claimed in claim 17, characterized in that page impositions constructed by at least one of the marking out and mask forming programme and registration hole forming programme and stored on said blank programming material can be accessed by either of said programmes. 45

50 19. A method of producing graphic material, said method being characterized by carrying out at least one of the functions of registration hole forming, marking out and mask forming, by driving a registration hole forming means, marking out means or mask forming means over a work supporting surface, said registration hole forming means being driven out of contact with the work and then being driven into contact with the work when at least one predetermined location is reached and then marking out and mask forming means being driven in contact with the work, as the case may be, and controlling the driven movement of the registration hole forming means, marking out and mask forming means by means of a computer which is programmed by at least one computer programme, whereby at least one registration hole, marking out line, or line of separation is formed in the work in a pattern dictated by the programme to produce the required graphic material. 55

20. Apparatus for the production of graphic material substantially as hereinbefore described with reference to Figs. 1 and 5 to 11 of the accompanying drawings.

21. Apparatus for the production of graphic material substantially as hereinbefore described with reference to Figs. 2 and 4 to 11 of the accompanying drawings.

60 22. Apparatus for the production of graphic material substantially as hereinbefore described with reference to Figs. 3 to 11 of the accompanying drawings. 60

23. Apparatus for the production of graphic material substantially as hereinbefore described with reference to Figs. 1 to 11 of the accompanying drawings.

65 24. A method of producing graphic material according to claim 19, and substantially as hereinbefore described. 65

25. A method of producing graphic material, substantially as hereinbefore described with reference to the accompanying drawings.

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